

NATIONAL BUREAU OF STANDARDS REPORT

NBS PROJECT

NBS REPORT

2120113

May 26, 1966

#9329

Interlaboratory Intercomparison of 400-Watt Mercury-Vapor Lamps

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Interlaboratory Intercomparison
of
400-Watt Mercury-Vapor Lamps

Abstract

Two groups of 400-watt mercury-vapor lamps were measured by each of seven laboratories. One group is composed of four clear-bulb lamps; the other is composed of four coated bulb lamps. The lamps were measured twice in each laboratory, once while holding the line voltage at 240 volts and again while holding the lamp wattage at 400-watts. The following lamp parameters were measured: lumens, amperes, lamp volts, and watts. Lumens per watt were computed from the above measurements. The results of measurements and a graphical analysis of the results are given.

Introduction

This intercomparison was undertaken to determine the uniformity of measurements on 400-watt mercury-vapor lamps made at the participating laboratories. The laboratories which participated are listed in the order in which they made their measurements.

1. Electrical Testing Laboratories
2. Duro Test
3. Westinghouse
4. Sylvania (Salem)
5. Sylvania (Manchester)
6. General Electric
7. National Bureau of Standards

Each laboratory followed its own customary procedure in making the measurements. In each laboratory measurements were made while holding the lamp wattage at 400 watts and except at Duro Test, they were measured again while holding the line voltage at 240 volts. Each laboratory measured the following parameters: lumens, amperes, lamp volts, watts and each laboratory computed lumens per watt.

Results of Measurements

The results reported by each laboratory are tabulated in tables 1 through 9. Average values for each lamp and for each laboratory are also given. The difference Δ between the average for each laboratory and the average for all the laboratory for each group of lamps is given for each measured parameter.

Analysis of Results

An analysis of the results of the measurements has been made following a modification of the method described by W. J. Youden (1), (2), and (3). The modification is described in National Bureau of Standards Report No. 6605, Interlaboratory Intercomparison of 32-Watt T12 Cool White Circline Lamps, and Report No. 6698, Interlaboratory Intercomparison of 40-Watt T12 Cool White Fluorescent Lamps. The analysis is shown on the graphs, figures 1 through 18. The point representing the measurements of an individual laboratory is designated by the first letter in the name of the laboratory. Sylvania's Salem Massachusetts laboratory is designated by SS and their Manchester N. H. laboratory is designated by S. M. The point representing the average of all the laboratories is designated by the letter A.

References

- (1) Graphical Diagnosis of Interlaboratory Test Results, Industrial Quality Control, Vol. XV., No. 11, May 1959.
- (2) Product Specification and Test Procedures, Industrial and Engineering Chemistry, Vol. 50, page 914, October 1958.
- (3) Circumstances Alter Cases, Industrial and Engineering Chemistry, Vol. 50, page 77A, December 1958.

Table I

400-Watt Mercury-Vapor Lamps (coated)

Lamp No.	ETL	Duro T	West	Syl (Salem)	Syl (Man)	G.E.	NBS	Ave.
Lumens at 240 Line Volts								
1	21380		20330	19680	20720	20728	20100	20490
2	21300		21277	20700	21100	20750	20500	20938
3	22360		22163	21660	22320	21838	21400	21957
4	20090		20100	19440	19880	19605	19300	19736
Ave	21282		20968	20370	21005	20730	20325	20780
Δ	+ 502		+ 188	- 410	+ 225	- 50	- 455	
% Δ	2.42		.90	1.97	1.08	.24	2.19	

Lumens
at 400 Watts

1	21140	21008	20947	20940	20900	20623	20200	20823
2	21760	21554	21730	21390	21640	21315	20900	21470
3	22410	22144	22060	22080	22380	21833	21400	22044
4	21250	21067	21187	20910	21220	20965	20400	21000
Ave	21640	21443	21481	21330	21535	21184	20725	21334
Δ	+ 306	+ 109	+ 147	- 4	+ 201	- 150	- 609	
% Δ	1.43	.51	.69	.02	.94	.70	2.85	

Table 2

400-Watt Mercury - Vapor Lamps (clear)

Lamp No.	ETL	Duro T	West	Syl. (Salem)	Syl (Man)	G.E.	NBS	Ave.
Lumens at 240 Line Volts								
1	20380		20170	20010	20180	19930	19600	20045
2	20520		20103	19890	20260	19945	19600	20053
3	20520		20457	20490	20500	20213	19900	20347
4	19860		19760	19440	19720	19328	19100	19535
Ave	20320		20123	19958	20165	19854	19550	19995
Δ	+ 325		+ 128	- 37	+ 170	- 141	- 445	
% Δ	1.63		.64	.18	.85	.71	2.22	

Lumens at 400 Watts

1	20710	19939	20453	20580	20440	20348	20000	20353
2	20710	19859	20287	20370	20360	20158	19700	20206
3	20760	20392	21120	21270	20920	20743	20500	20815
4	20490	19636	20127	20190	20180	19935	19600	20023
Ave	20668	19957	20497	20602	20475	20296	19950	20349
Δ	+ 319	- 392	+ 148	+ 253	+ 126	- 53	- 399	
% Δ	1.57	1.93	.73	1.24	.62	.26	1.96	

Table 3

400-Watt Mercury-Vapor Lamps (Coated)

<u>Lamp No.</u>	<u>ETL</u>	<u>Duro T</u>	<u>West</u>	<u>Syl.</u> <u>(Salem)</u>	<u>Syl</u> <u>(Man)</u>	<u>G.E.</u>	<u>NBS</u>	<u>Ave.</u>
Amperes at 240 Line Volts								
1	3.03		2.91	2.87	2.89	2.99	2.92	2.94
2	3.27		3.29	3.26	3.21	3.27	3.24	3.26
3	3.12		3.11	3.10	3.07	3.11	3.06	3.10
4	3.43		3.41	3.42	3.38	3.42	3.40	3.41
Ave	3.21		3.18	3.16	3.14	3.20	3.16	3.18
Δ	+0.03		0	-.02	-.04	+0.02	-.02	
% Δ	.9		0	.6	1.3	.6	.6	

Amperes at 400 Watts

1	3.00	2.96	2.98	3.01	2.95	2.99	2.94	2.98
2	3.33	3.27	3.30	3.35	3.31	3.32	3.30	3.31
3	3.13	3.08	3.17	3.15	3.11	3.12	3.08	3.12
4	3.59	3.57	3.59	3.61	3.59	3.59	3.56	3.59
Ave	3.26	3.22	3.26	3.28	3.24	3.26	3.22	3.25
Δ	+0.01	-.03	+0.01	+0.03	-.01	+0.01	-.03	
% Δ	.3	.9	.3	.9	.3	.3	.9	

Table 4

400-Watt Mercury Lamps (Clear)

<u>Lamp No.</u>	<u>ETL</u>	<u>Duro T</u>	<u>West</u>	<u>Syl</u> <u>(Salem)</u>	<u>Syl</u> <u>(Man)</u>	<u>G. E.</u>	<u>NBS</u>	<u>Ave.</u>
Amperes at 240 Line Volts								
1	3.24		3.26	3.25	3.22	3.26	3.22	3.24
2	3.19		3.20	3.17	3.16	3.19	3.14	3.18
3	3.31		3.32	3.31	3.30	3.32	3.28	3.31
4	3.25		3.30	3.30	3.26	3.30	3.26	3.28
Ave	3.25		3.27	3.26	3.24	3.27	3.22	3.25
Δ	0		+0.02	+0.01	-.01	+0.02	-.03	
% Δ	0		.6	.3	.3	.6	.9	

Amperes at 400-Watts

1	3.26	3.21	3.29	3.33	3.29	3.30	3.27	3.28
2	3.23	3.18	3.20	3.23	3.20	3.22	3.19	3.21
3	3.34	3.33	3.39	3.41	3.37	3.39	3.36	3.37
4	3.33	3.26	3.33	3.40	3.36	3.36	3.34	3.34
Ave	3.29	3.25	3.30	3.34	3.31	3.32	3.29	3.30
Δ	-.01	-.05	0	+0.04	+0.01	+0.02	-.01	
% Δ	.3	1.5	0	1.2	.3	.6	.3	

Table 5

400 Watt Mercury-Vapor Lamps (Coated)

<u>Lamp No.</u>	<u>ETL</u>	<u>Duro T</u>	<u>West</u>	<u>Syl. (Salem)</u>	<u>Syl. (Man)</u>	<u>G.E.</u>	<u>NBS</u>	<u>Ave.</u>
Lamp Volts at 240 Line Volts								
1	145.3		148	149	149	145.8	146	147.2
2	130.5		129	130	130	130.3	128	129.6
3	139.2		138	139	139	139.2	138	138.7
4	121.0		120	120	120	120.5	119	120.1
Ave	134.0		133.8	134.5	134.5	134.0	132.8	133.9
Δ	+ .1		- .1	+ .6	+ .6	+ .1	-1.1	
% Δ	.07		.07	.45	.45	.07	.82	

Lamp Volts at 400 Watts

1	145.3	147.2	148	149	149	146.0	145	147.1
2	130.8	129.4	129	130	130	130.7	128	129.7
3	139.2	138.1	138	139	139	139.2	138	138.6
4	121.0	119.8	120	120	120	121.0	120	120.3
Ave	134.1	133.6	133.8	134.5	134.5	134.2	132.8	133.9
Δ	+ .2	- .3	- .1	+ .6	+ .6	+ .3	-1.1	
% Δ	.15	.22	.07	.45	.45	.22	.82	

Table 6

400 Watt Mercury-Vapor Lamps (Clear)

<u>Lamp No.</u>	<u>ETL</u>	<u>Duro T</u>	<u>West</u>	<u>Syl. (Salem)</u>	<u>Syl. (Man)</u>	<u>G.E.</u>	<u>NBS</u>	<u>Ave.</u>
Lamp Volts at 240 Line Volts								
1	134.0		130	131	131	131.1	128	130.8
2	136.3		133	135	135	135.1	134	134.7
3	129.5		125	128	126	127.0	126	126.9
4	132.2		128	128	128	128.6	127	128.6
Ave	133.0		129.0	130.5	130.0	130.5	128.8	130.3
Δ	+ 2.7		- 1.3	+ .2	- .3	+ .2	- 1.5	
% Δ	2.1		1.0	.2	.2	.2	1.1	

Lamp Volts at 400 Watts

1	134.0	132.4	130	131	131	131.4	129	131.3
2	135.8	133.5	134	135	135	134.9	133	134.5
3	129.3	127.3	125	128	128	127.8	126	127.3
4	132.4	130.0	128	128	128	128.9	126	128.8
Ave	132.9	130.8	129.3	130.5	130.5	130.8	128.5	130.5
Δ	+ 2.4	+ .3	- 1.2	0	0	+ .3	- 2.0	
% Δ	1.8	.2	.9	0	0	.2	1.5	

Table 7

400-Watt Mercury-Vapor Lamps (Coated)

<u>Lamp No.</u>	<u>ETL</u>	<u>Duro T</u>	<u>West</u>	<u>Syl. (Salem)</u>	<u>Syl. (Man)</u>	<u>G.E.</u>	<u>NBS</u>	<u>Ave.</u>
Watts at 240 Line Volts								
1	399.6		391	380	397	401	399	394.6
2	398.6		394	388	390	394	391	392.6
3	399.6		399	394	399	399	399	398.3
4	383.6		382	378	376	380	382	380.3
Ave	395.4		391.5	385.0	390.5	393.5	392.8	391.4
Δ	+ 4.0		+ .1	- 6.4	- .9	+ 2.1	+ 1.4	
% Δ	1.0		.03	1.6	.2	.5	.4	

400-Watt Mercury-Vapor Lamps (Clear)
Watts at 240 Line Volts

1	399.6		395	390	396	395	391	394.4
2	399.6		396	394	397	398	398	397.1
3	399.6		389	389	390	392	389	391.4
4	392.6		392	388	391	393	389	390.9
Ave	397.9		393.0	390.2	393.5	394.5	391.8	393.5
Δ	+ 4.4		- .5	- 3.3	0	+ 1.0	- 1.7	
% Δ	1.1		.1	.8	0	.3	.4	

Table 8
400-Watt Mercury-Vapor Lamps (Coated)

<u>Lamp No.</u>	<u>ETL</u>	<u>Duro T</u>	<u>West</u>	<u>Syl. (Salem)</u>	<u>Syl. (Man)</u>	<u>G.E.</u>	<u>NBS</u>	<u>Ave.</u>
Lumens per Watt at 240 Line Volts								
1	53.5		51.6	51.8	52.2	51.7	50.4	51.9
2	53.4		54.1	53.4	54.1	52.7	52.4	53.4
3	56.0		55.7	55.0	55.9	54.7	53.6	55.2
4	52.4		52.6	51.4	52.9	51.6	50.5	51.9
Ave	53.8		53.5	52.9	53.8	52.7	51.7	53.1
Δ	+ .7		+ .4	- .2	+ .7	- .4	-1.4	
% Δ	1.3		.8	.4	1.3	.8	2.6	

Lumens per Watt at 400 Watts

1	52.9	52.72	52.4	52.4	52.2	51.6	50.5	52.1
2	54.4	53.88	54.3	53.5	54.2	53.3	52.2	53.7
3	56.0	55.36	55.2	55.2	56.0	54.6	53.5	55.1
4	53.1	52.66	52.3	52.3	53.0	52.4	51.0	52.4
Ave	54.1	53.65	53.6	53.3	53.8	53.0	51.8	53.3
Δ	+ .8	+ .35	+ .3	0	+ .5	- .3	-1.5	
% Δ	1.5	.7	.6	0	.9	.6	2.8	

Table 9
400-Watt Mercury-Vapor Lamps (Clear)

<u>Lamp No.</u>	<u>ETL</u>	<u>Duro T</u>	<u>West</u>	<u>Syl. (Salem)</u>	<u>Syl. (Man)</u>	<u>G.E.</u>	<u>NBS</u>	<u>Ave.</u>
Lumens per Watt at 240 Line Volts								
1	51.0		51.2	51.3	51.0	50.5	50.1	50.8
2	51.4		50.3	50.5	51.0	50.1	49.2	50.4
3	51.4		52.5	52.7	52.6	51.6	51.2	52.0
4	50.6		50.5	50.1	50.4	49.2	49.1	50.0
Ave	51.1		51.1	51.2	51.2	50.4	49.9	50.8
Δ	+ .3		+ .3	+ .4	+ .4	- .4	- .9	
% Δ	.6		.6	.8	.8	.8	1.8	

Lumens per Watt at 400 Watts

1	51.8	49.84	51.2	51.5	51.1	50.9	50.0	50.9
2	51.8	49.64	50.7	50.9	50.9	50.4	49.2	50.5
3	51.9	50.98	52.8	53.2	52.3	51.9	51.2	52.0
4	51.2	49.09	50.3	50.5	50.4	49.8	49.0	50.0
Ave	51.7	49.89	51.2	51.5	51.2	50.8	49.8	50.9
Δ	+ .8	-1.01	+ .3	+ .6	+ .3	- .1	-1.1	
% Δ	1.6	2.0	.6	1.2	.6	.2	2.2	

Figure 1
400-Watt Mercury-Vapor Lamps (Coated)

Lumens
At 240 Line Volts

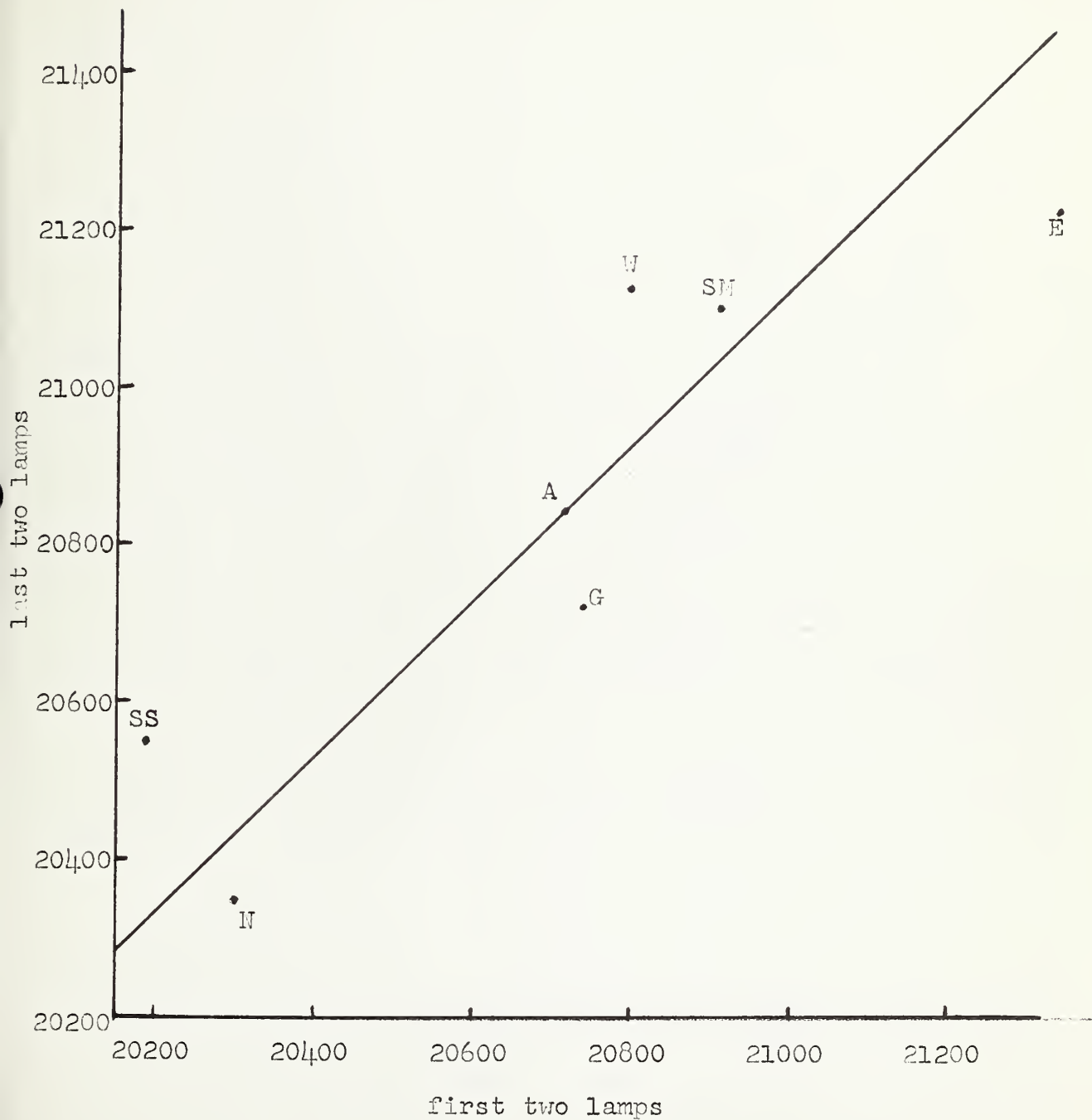


Figure 2

400-Watt Mercury-Vapor Lamps (Coated)

Lumens
At 400 Watts

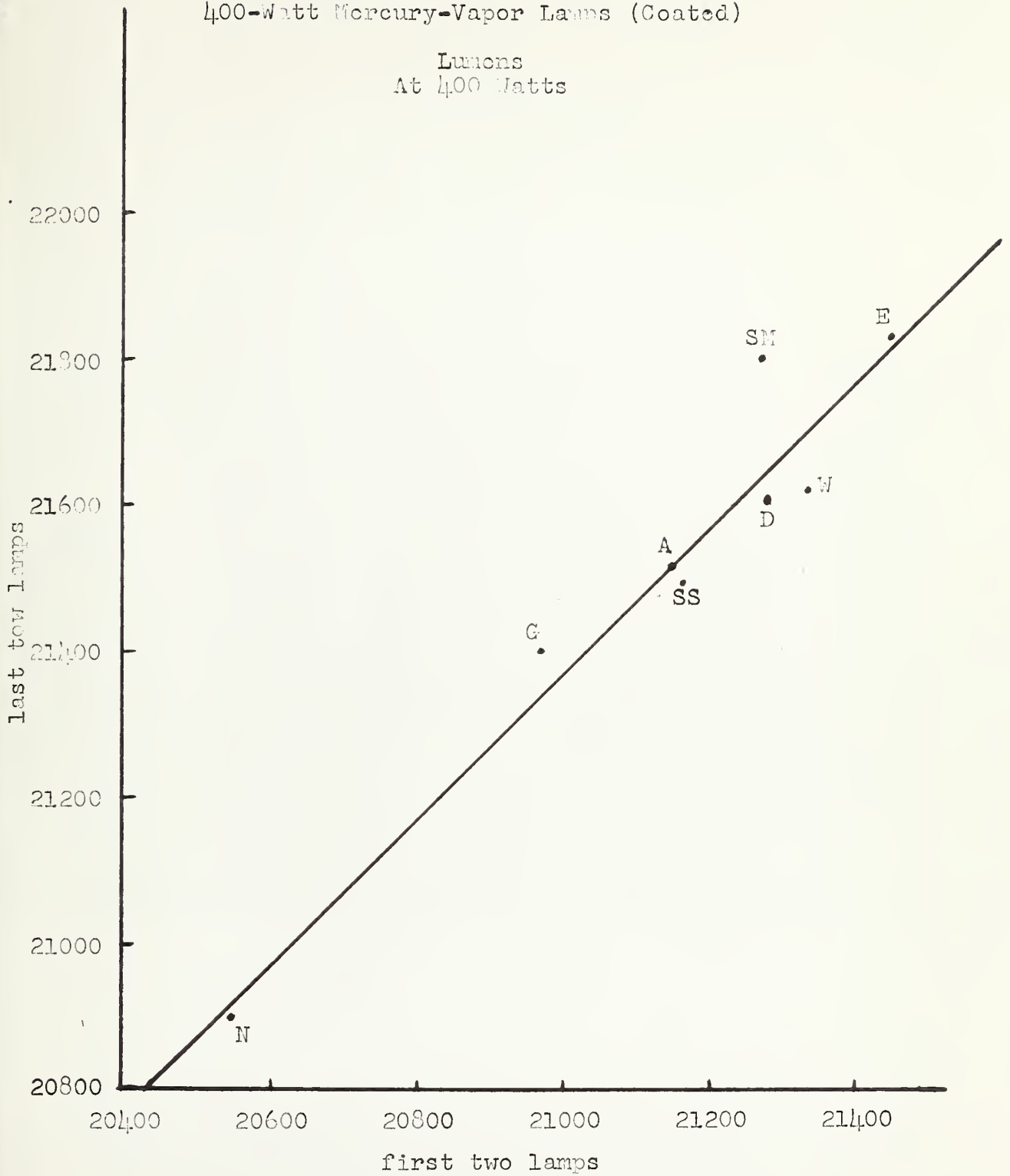


Figure 3
400-Watt Mercury-Vapor Lamps (Clear)

Lumens
At 240 Line Volts

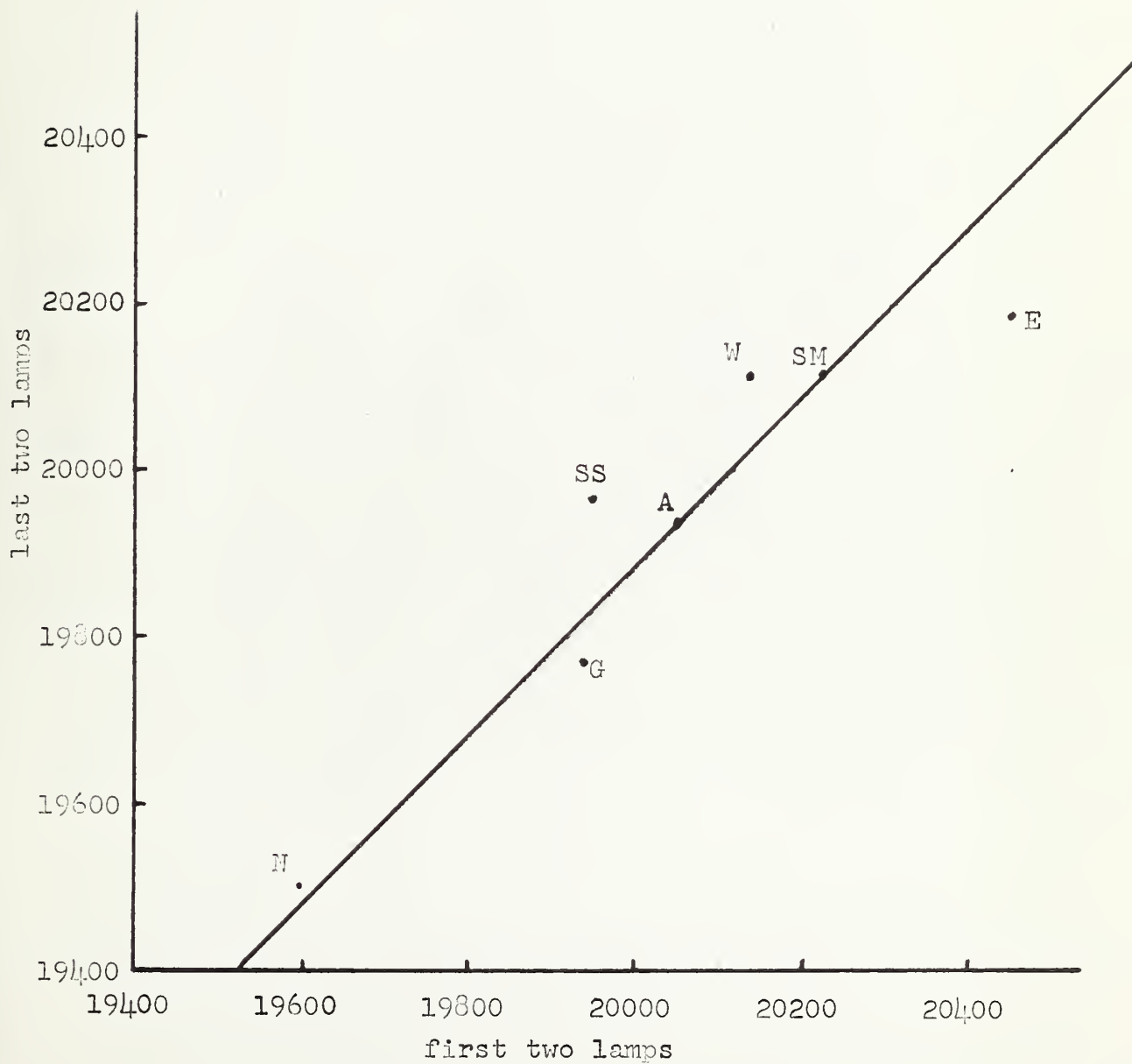


Figure 4
400-Watt Mercury-Vapor Lamps (Clear)

Lumens
At 400 Watts

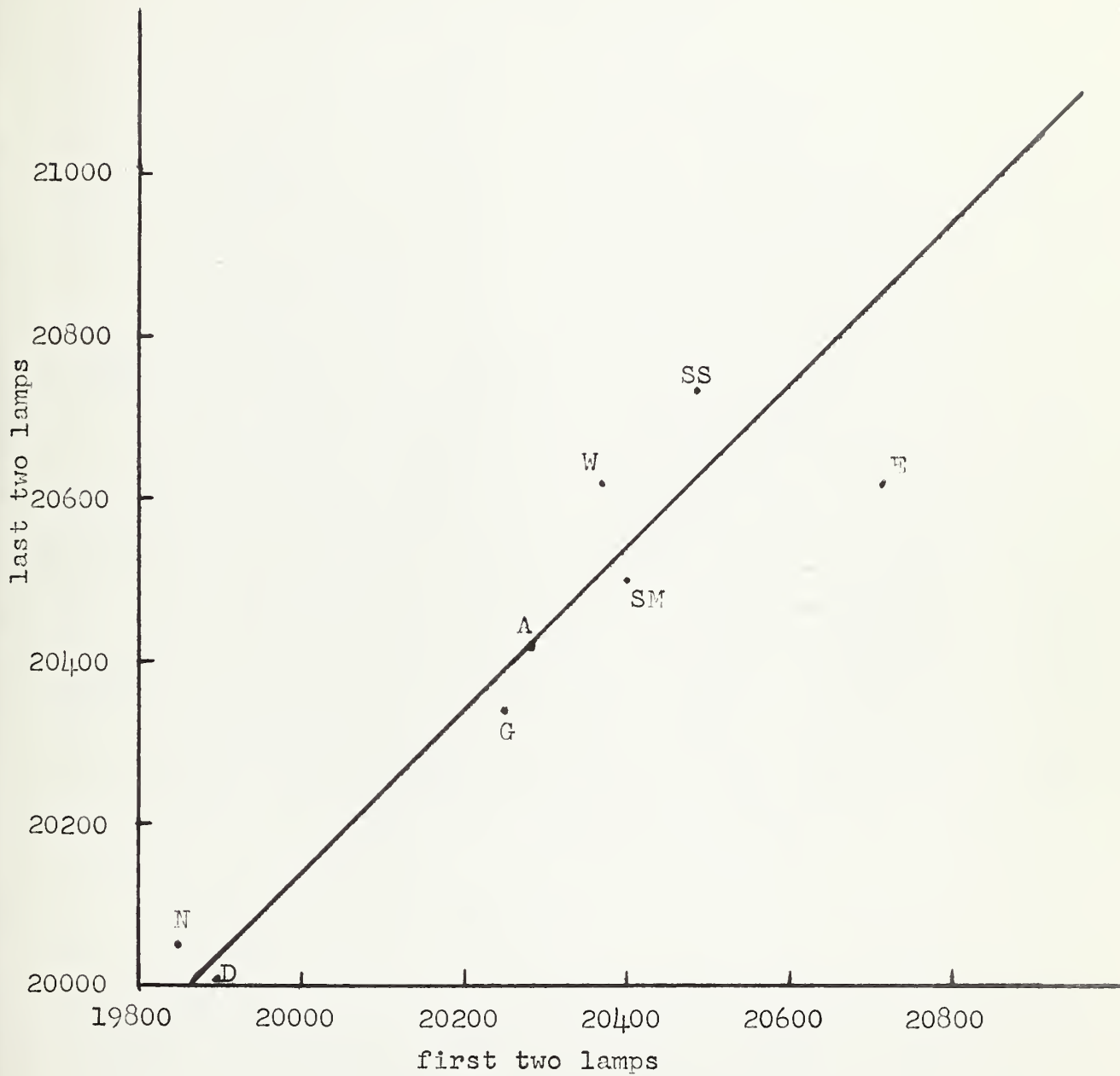


Figure 5
400-Watt Mercury-Vapor Lamps (Coated)

Amperes
At 240 Line Volts

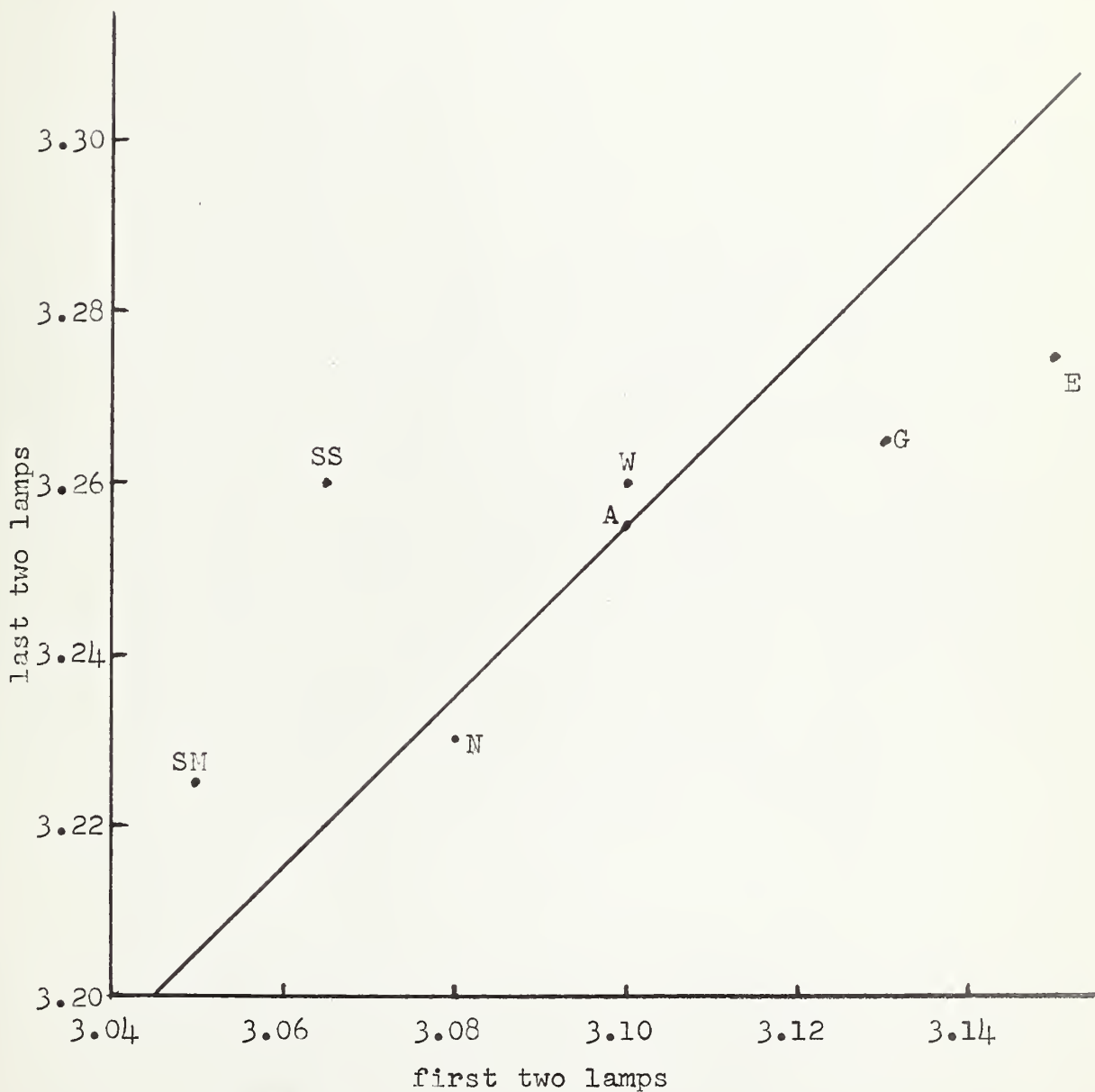


Figure 6

400-Watt Mercury-Vapor Lamps (Coated)

Amperes
at 400 Watts

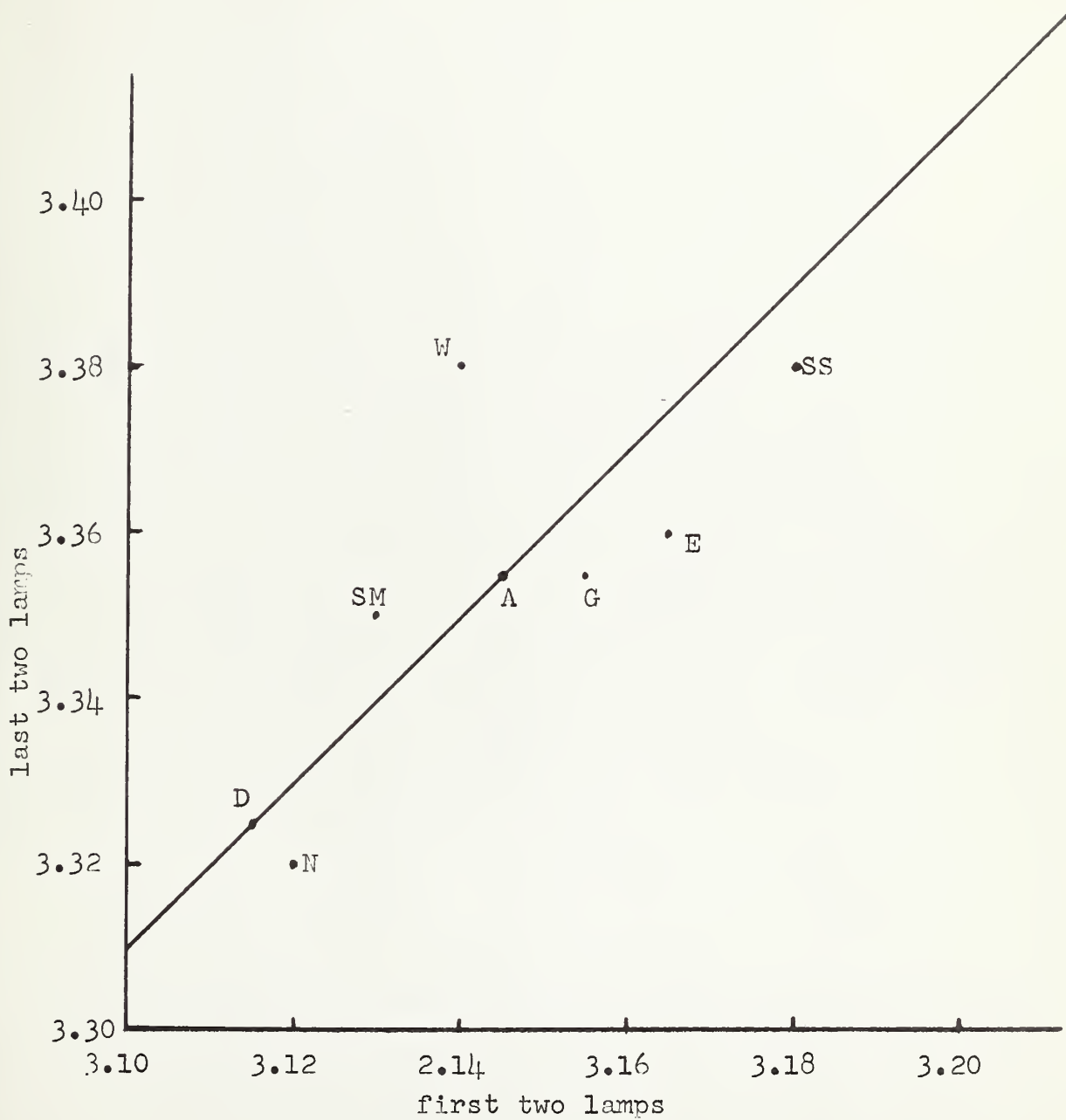


Figure 7
400-Watt Mercury-Vapor Lamps (Clear)

Amperes
At 240 Line Volts

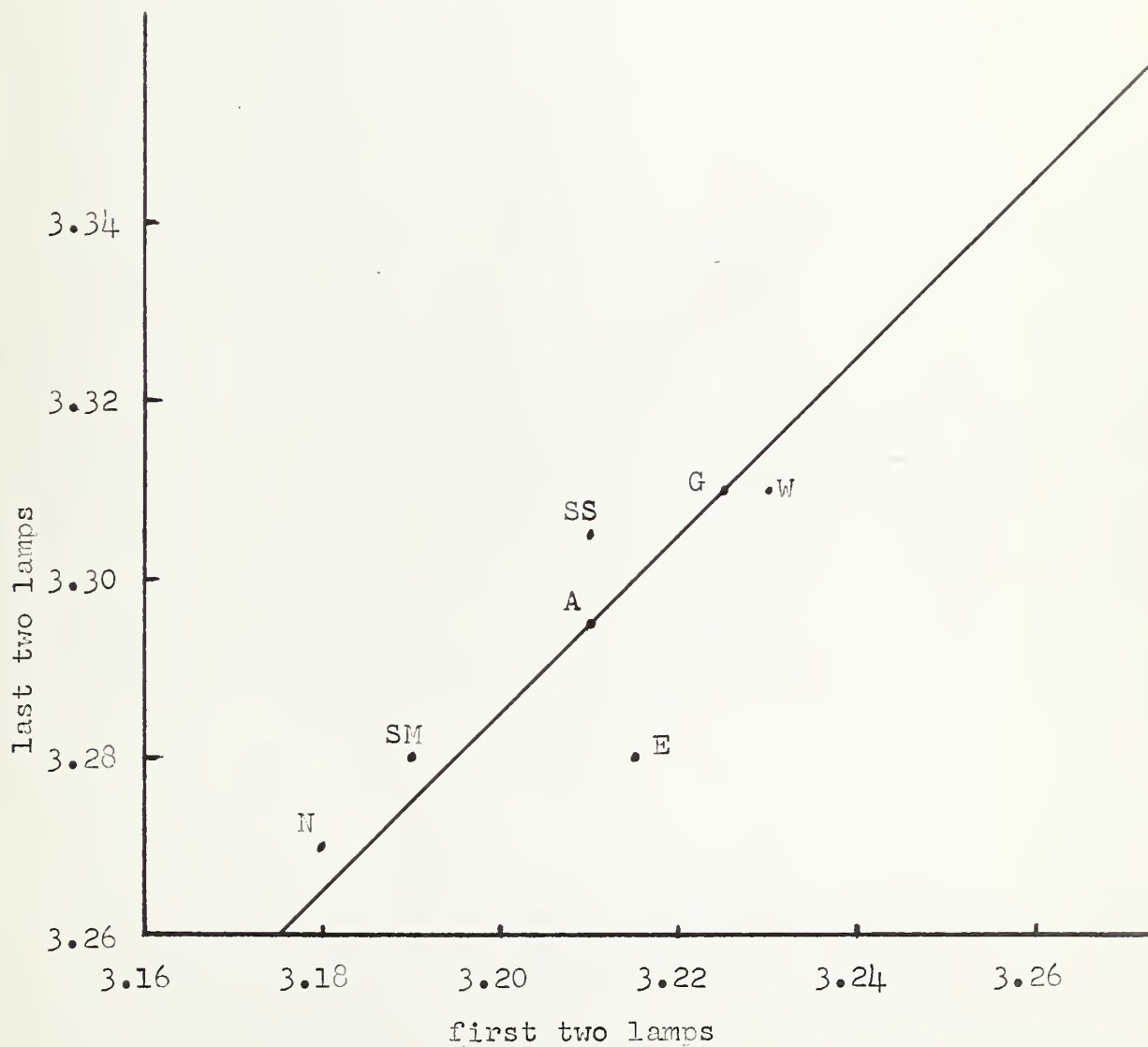


Figure 8
400-Watt Mercury-Vapor Lamps (Clear)
Amperes
At 400 Watts

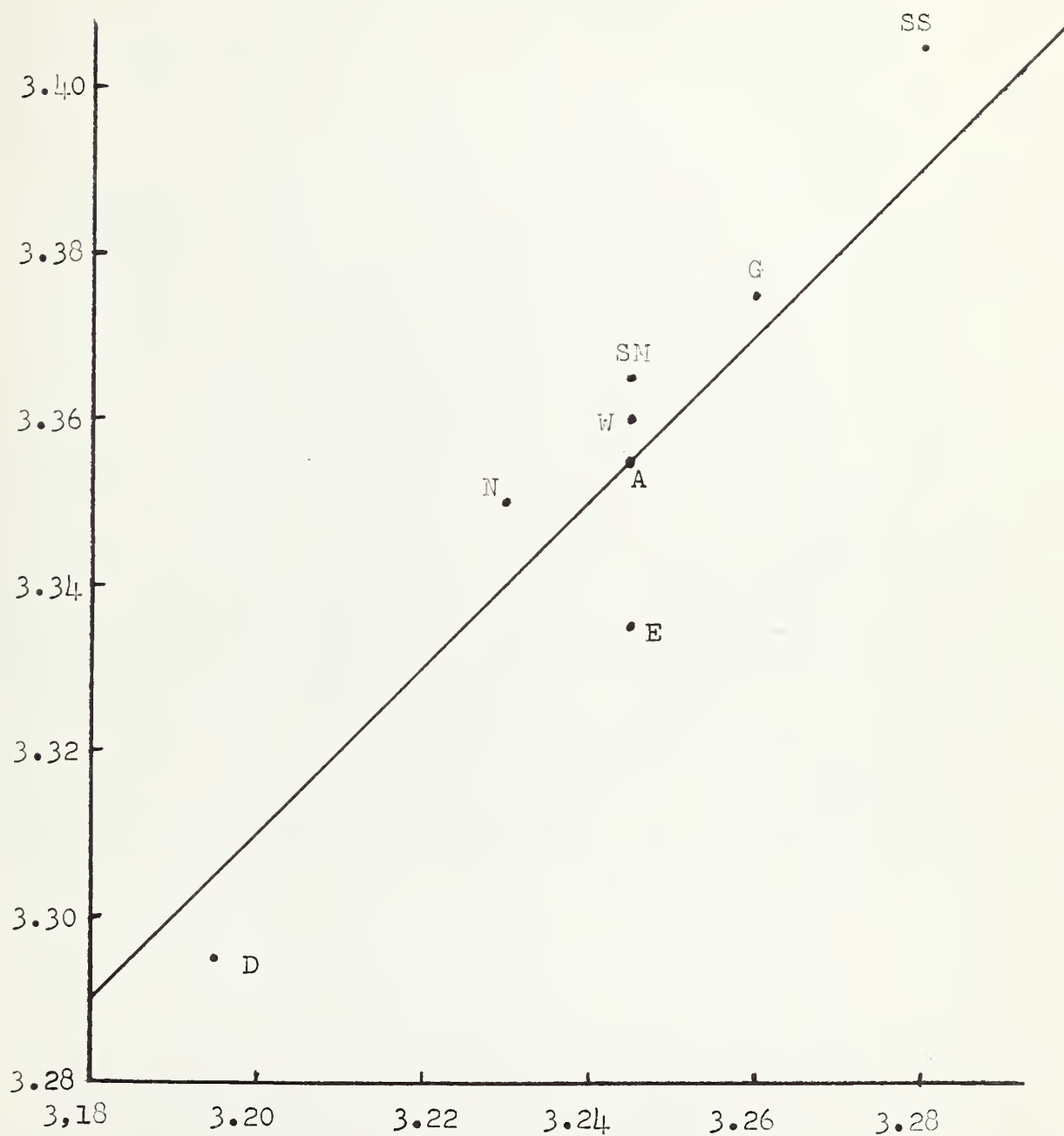


Figure 9

400-Watt Mercury-Vapor Lamps (Coated)

Lamp Volts
At 240 Line Volts

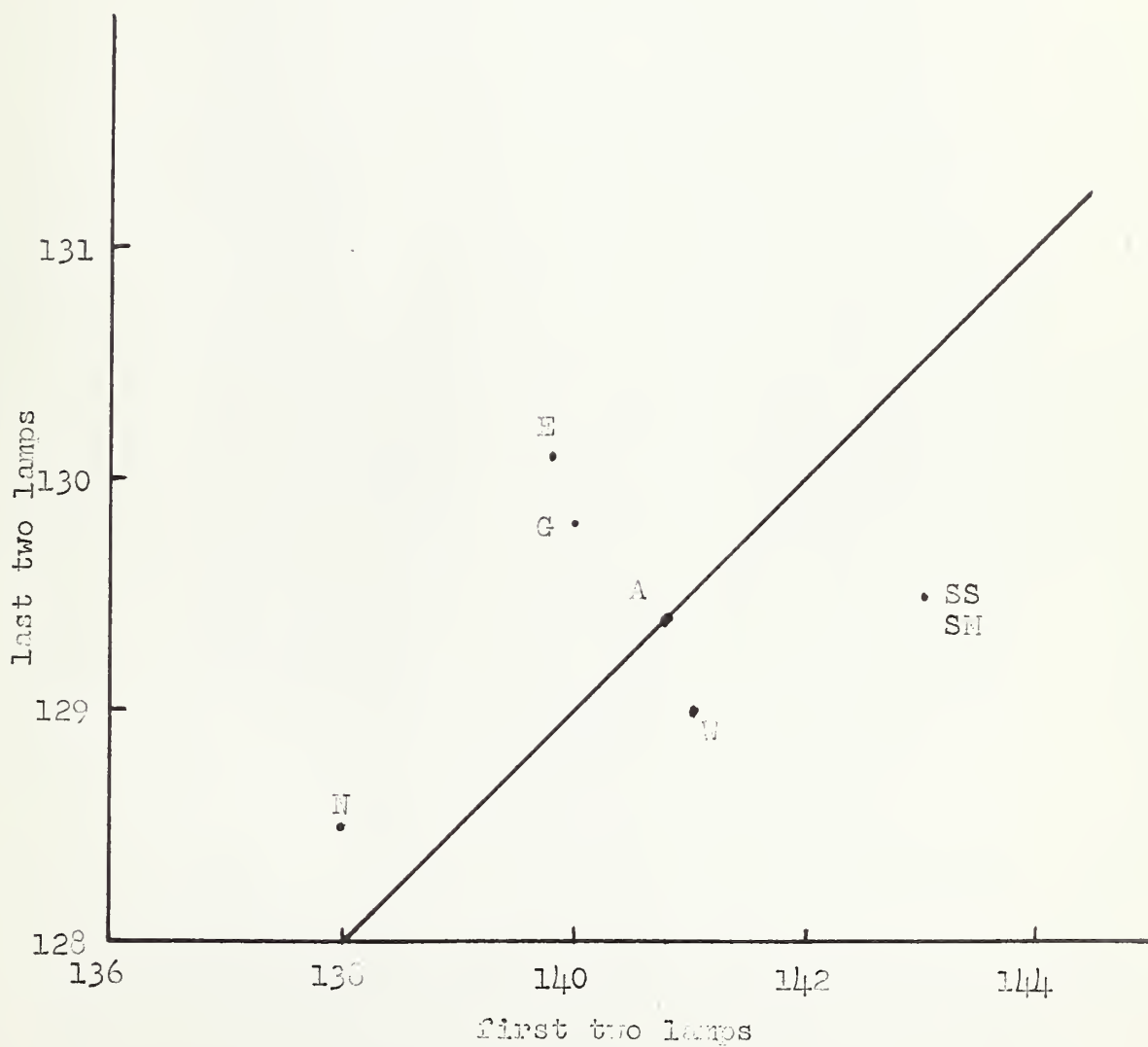


Figure 10

400-Watt Mercury-Vapor Lamps (Coated)

Lamp Volts
At 400 Watts

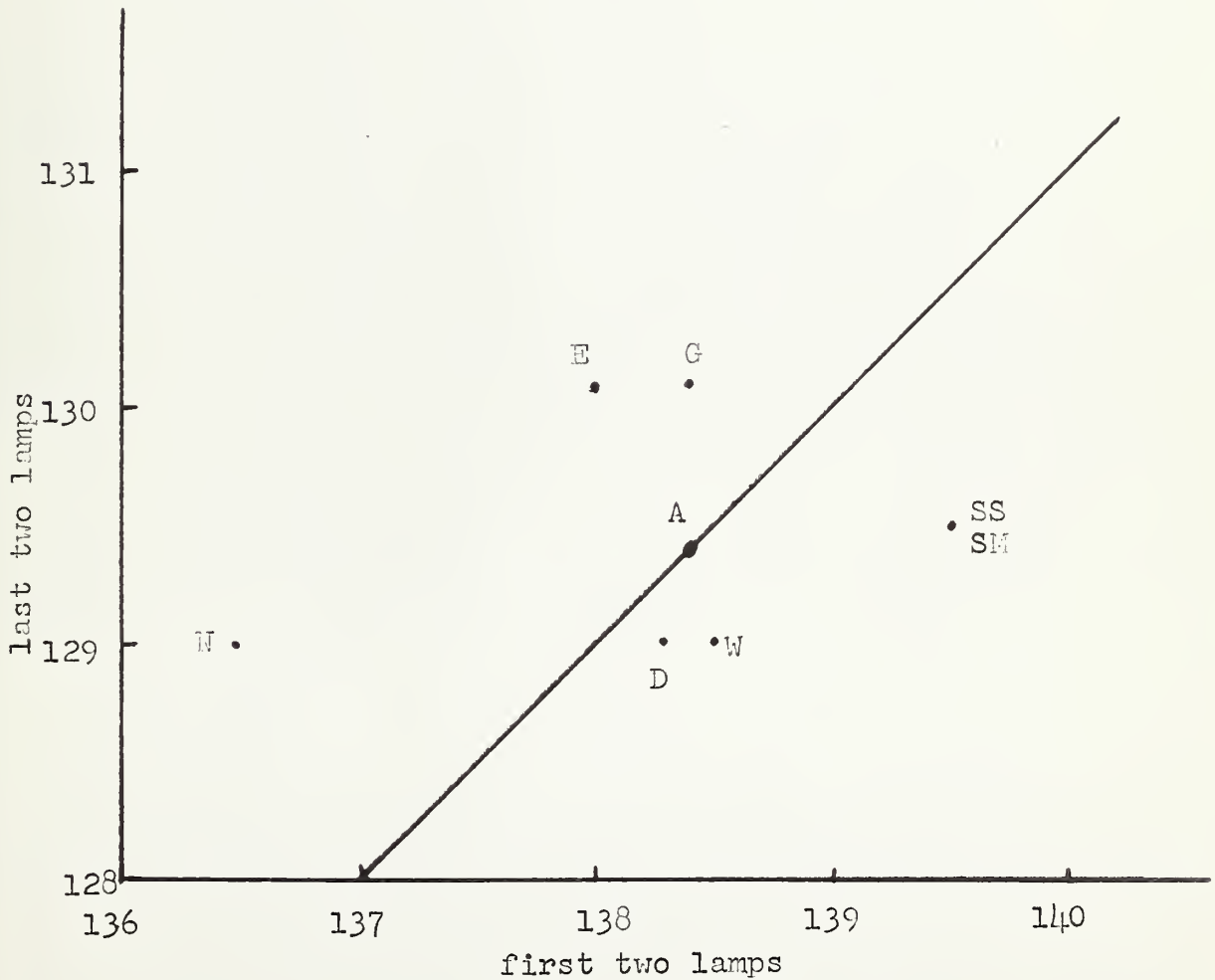


Figure 11

400-Watt Mercury-Vapor Lamps (Clear)

Lamp Volts
At 240 Line Volts

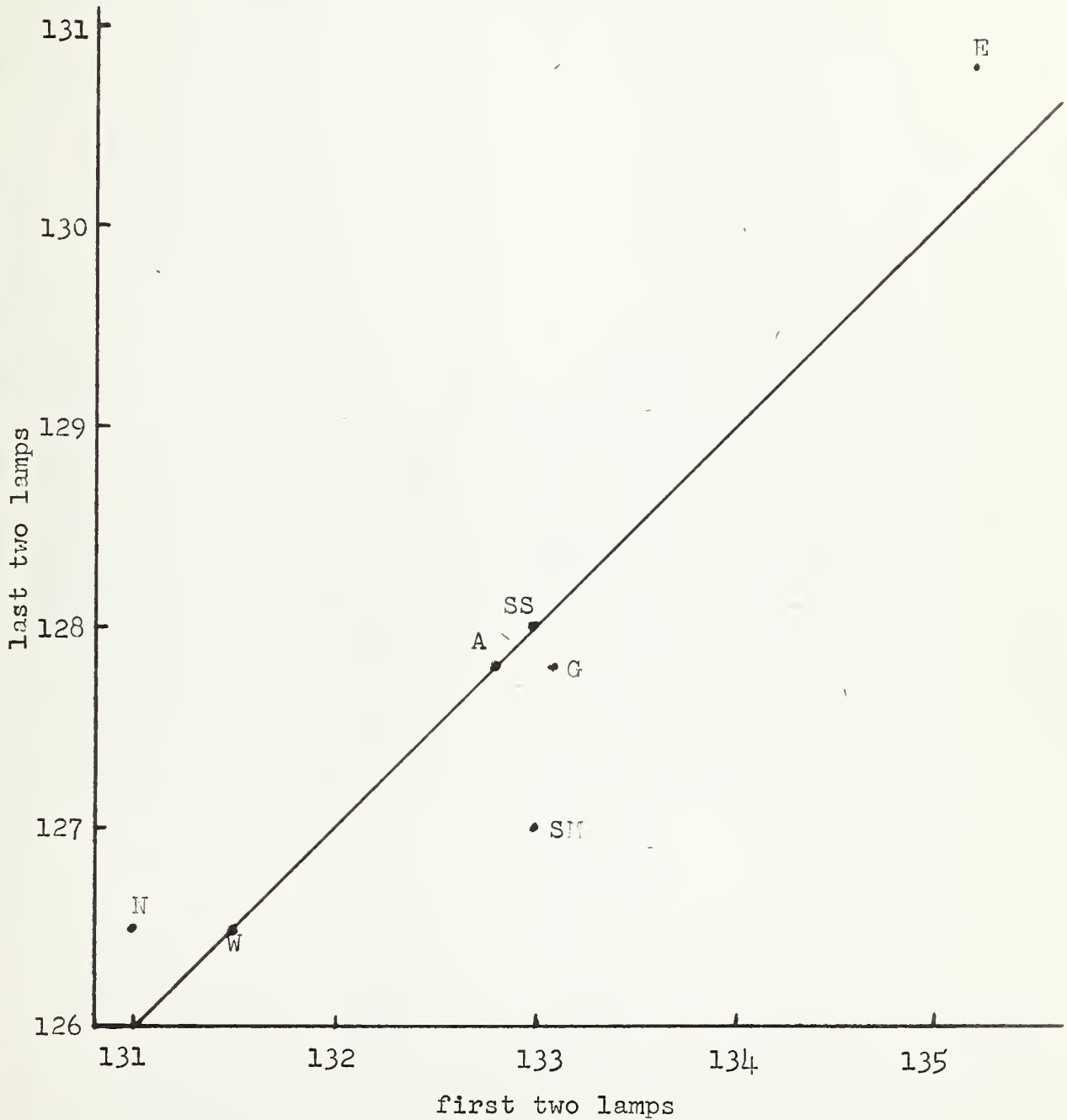


Figure 12
400-Watt Mercury-Vapor Lamps (Clear)

Lamp Volts
At 400 Watts

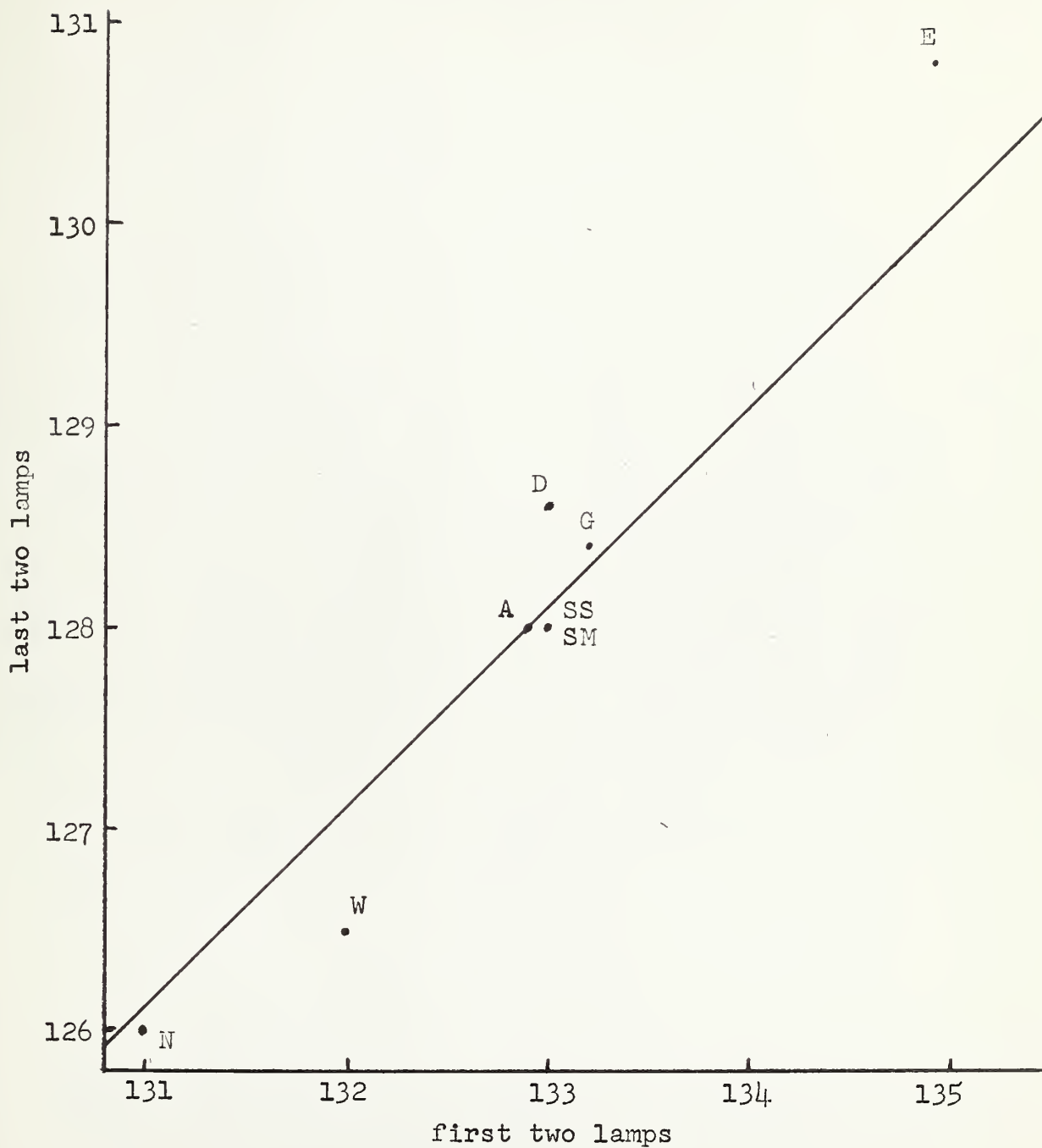


Figure 13

400-Watt Mercury-Vapor Lamps (Coated)

Watts
At 240 Line Volts

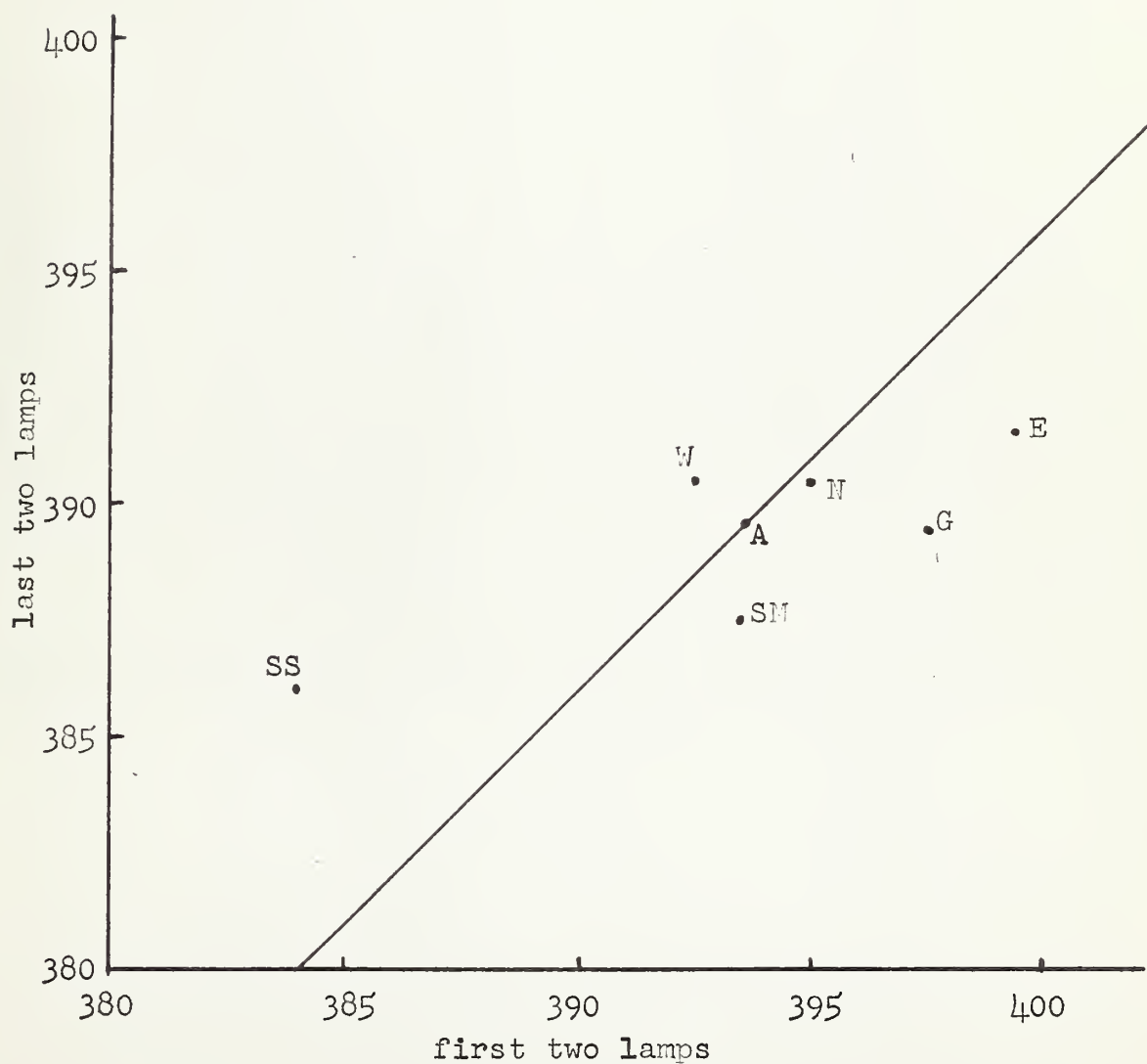


Figure 14

400-Watt Mercury-Vapor Lamps (Clear)

Watts
At 240 Line Volts

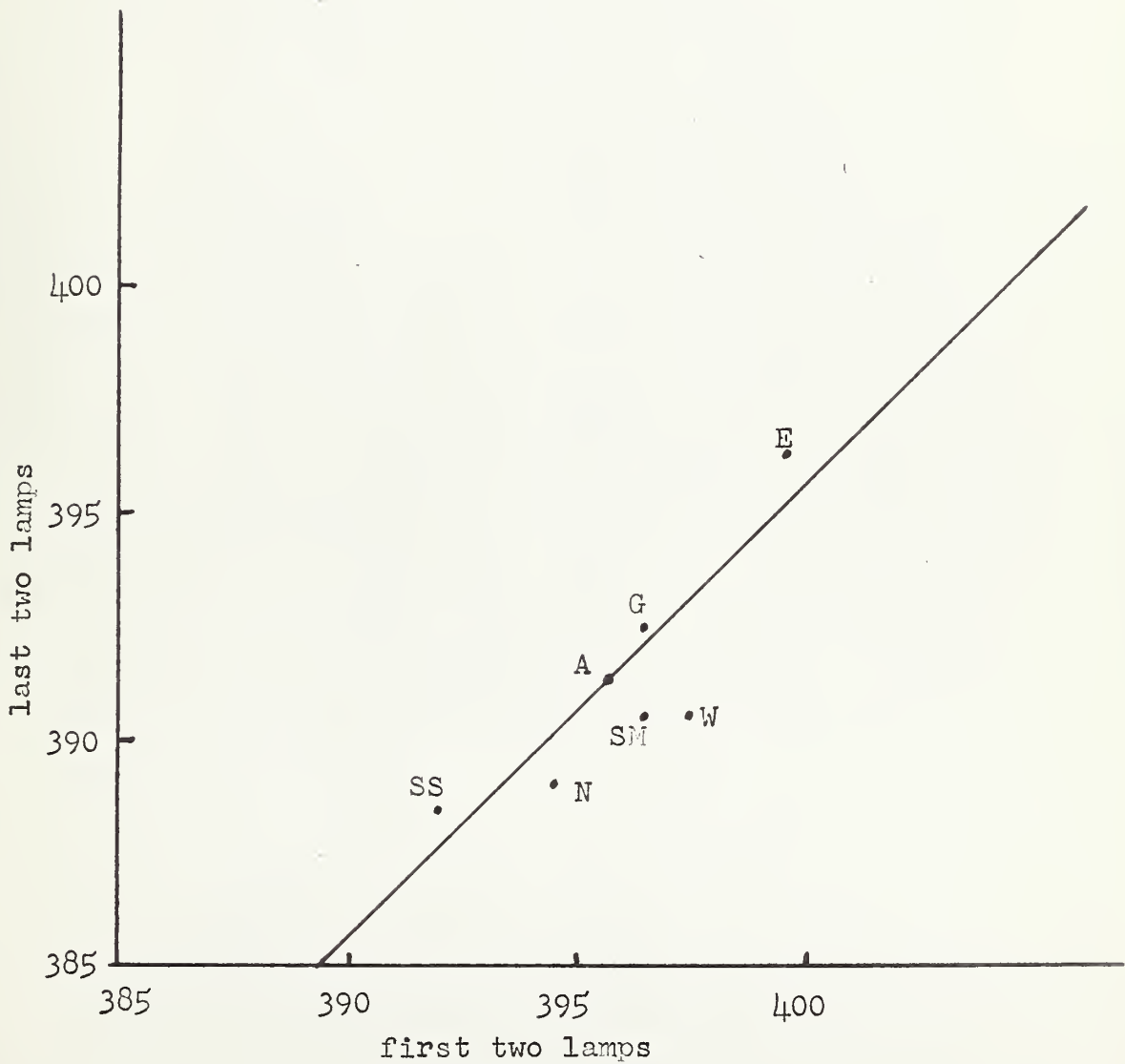


Figure 15

400-Watt Mercury-Vapor Lamps (Coated)

Lumens per Watt
At 240 Line Volts

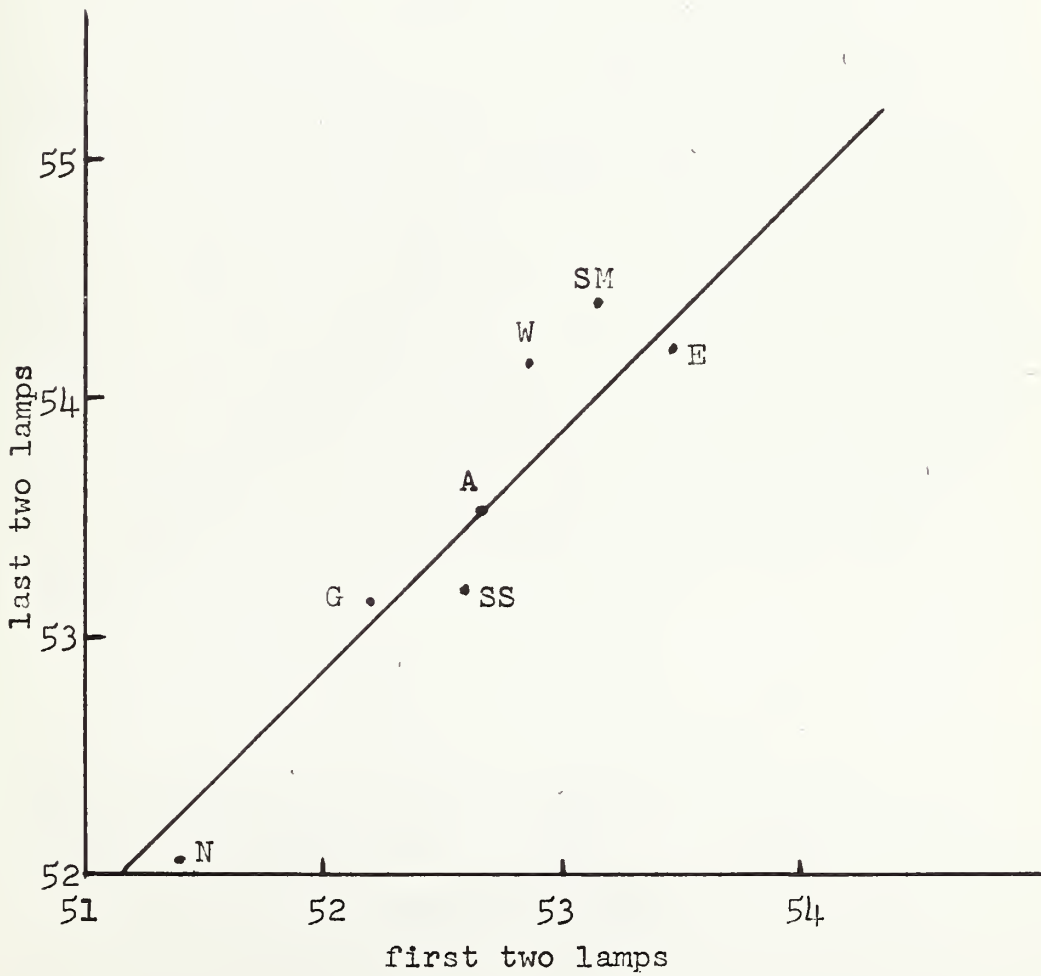


Figure 16

400-Watt Mercury-Vapor Lamps (Coated)

Lumens per Watt
At 400 Watts

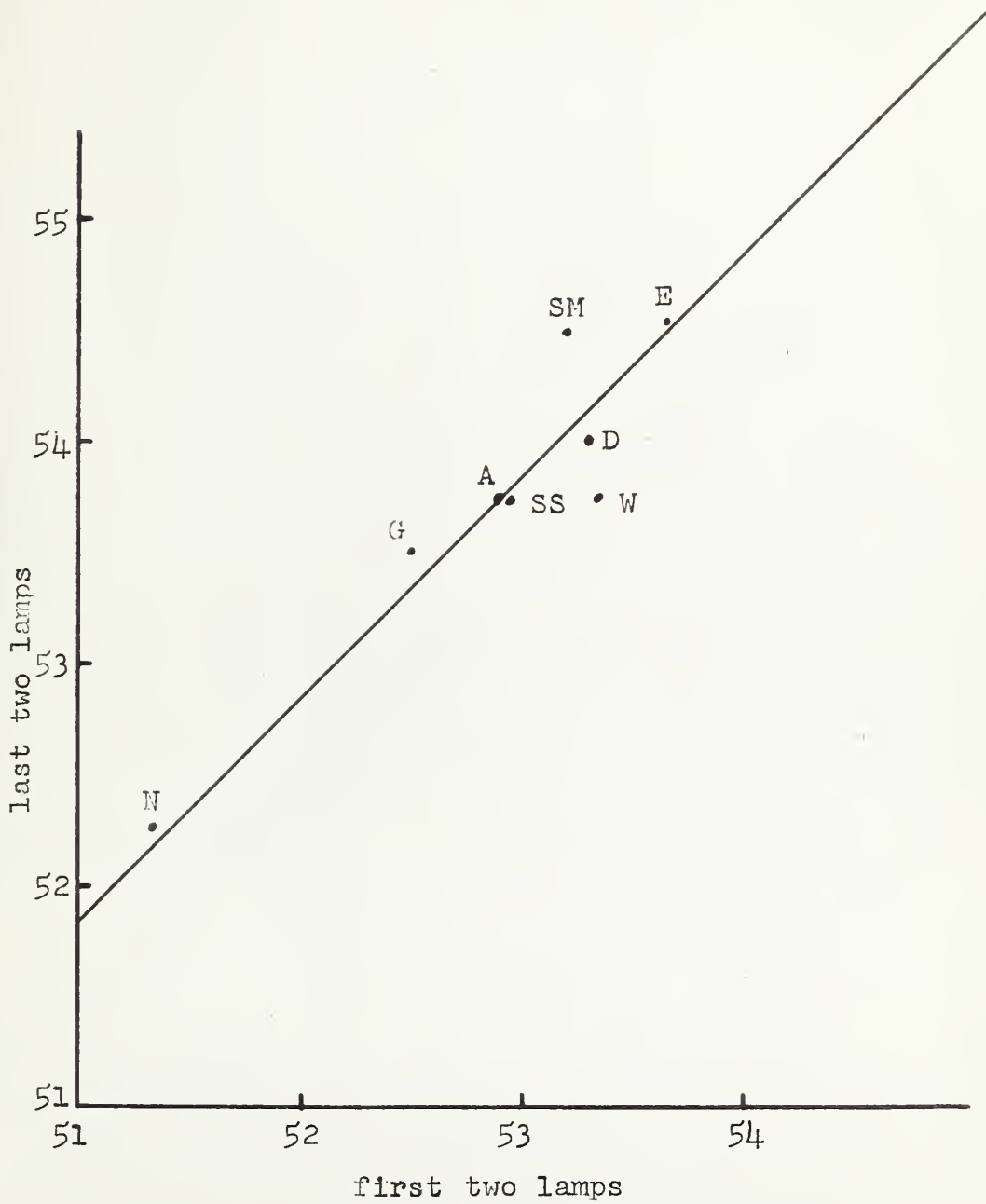


Figure 17

400-Watt Mercury-Vapor Lamps (Clear)

Lumens per Watt
At 240 Line Volts

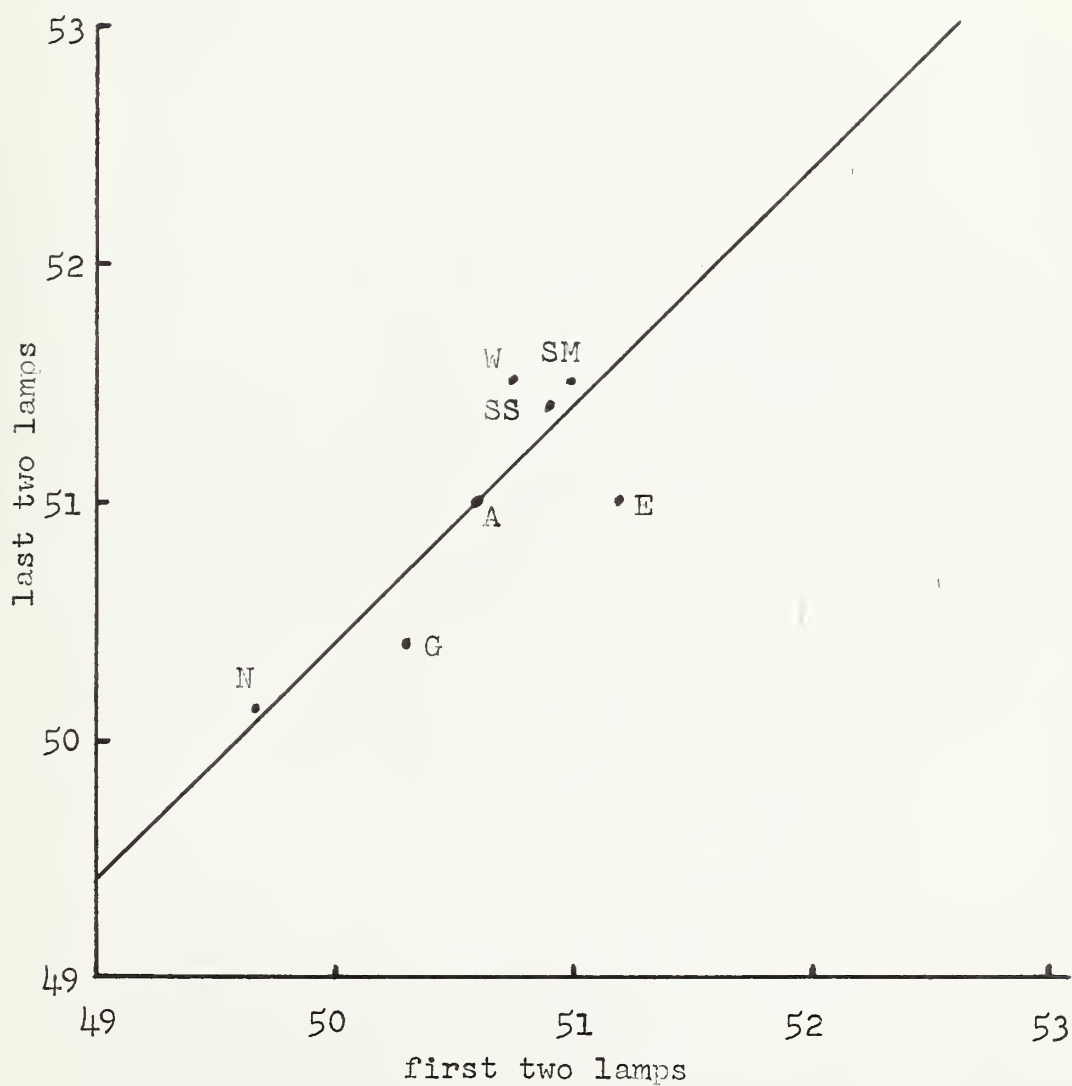


Figure 18

400-Watt Mercury-Vapor Lamps (Clear)

Lumens per Watt
At 400 Watts

